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## EFFECT OF COLD STORAGE AND AGE OF SEED ON GERMINATION AND YIELD OF PEANUTS

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### CONTENTS

|                                   | Page |                                       | Page |
|-----------------------------------|------|---------------------------------------|------|
| Effect of cold storage.....       | 1    | Effect of cold storage—Continued..... |      |
| Experimental work in 1921-22..... | 1    | Summary of storage experiments.....   | 7    |
| Experimental work in 1922-23..... | 3    | Effect of age.....                    | 8    |
| Experimental work in 1923-24..... | 4    | Discussion.....                       | 9    |
| Experimental work in 1924-25..... | 5    | Summary of age experiments.....       | 12   |
| Experimental work in 1925-26..... | 6    |                                       |      |

### EFFECT OF COLD STORAGE

It is often desirable to keep peanut seed for extended periods without deterioration of vitality. Protection from insect injury is of prime importance in conserving the vitality of the seed. Cold storage of peanuts is commonly practiced to prevent spoilage and to eliminate the danger of insect injury.

The investigations reported in the first part of this circular were undertaken to determine the effect of cold storage on the vitality of peanut seed. The seed was stored in the cold-storage plant at Arlington Experiment Farm, Rosslyn, Va., but all the field work was conducted in cooperation with the Pee Dee Experiment Station of the State Agricultural Experiment Station at Florence, S. C.

### EXPERIMENTAL WORK IN 1921-22

In May, 1921, plantings of one-tenth of an acre each of African, Improved Spanish, Jumbo, Spanish, and Valencia varieties of peanuts were made at the Pee Dee substation. These were cared for throughout the season and were harvested and stacked in the field on September 15, in the usual manner. A portion of the stock from these plantings was employed for the cold-storage tests of 1922. The seed was picked the latter part of October, 1921, shipped to Arlington Experiment Farm, and kept in natural storage at a temperature of about 70° F. under ordinary room conditions until the latter part of January, 1922, when half of each lot was shelled by hand. All lots were placed in muslin bags and packed in slatted crates. On February 3, 1922, shelled and unshelled lots of each variety were placed in cold storage at 32° and 40°, and in common storage at 70°. On May 10, 1922, all these lots were removed from storage and shipped to South Carolina, where they were planted on May 15. Peanuts stored in the unshelled state were shelled by hand before planting. The seeds were placed exactly 6 inches apart in the rows. In 1922

and 1923 only germination counts were made, but in the other years that this work was in progress yields were also recorded. The results for 1921-22 are presented in Tables 1 and 2.

TABLE 1.—*Germination in 1922 of five varieties of peanut seed grown in 1921 and stored at 32°, 40°, and in common storage at 70° F.<sup>1</sup>*

| Variety               | Storage temperature | Germination    |                  | Variety       | Storage temperature | Germination    |                  |
|-----------------------|---------------------|----------------|------------------|---------------|---------------------|----------------|------------------|
|                       |                     | Stored shelled | Stored unshelled |               |                     | Stored shelled | Stored unshelled |
|                       | ° F.                | Per cent       | Per cent         |               | ° F.                | Per cent       | Per cent         |
| African.....          | 32                  | 39.2           | 68.9             | Spanish.....  | 32                  | 73.9           | 93.3             |
|                       | 40                  | 67.5           | 71.0             |               | 40                  | 74.5           | 89.7             |
|                       | 70                  | 40.0           | 53.1             |               | 70                  | 50.8           | 81.1             |
| Improved Spanish..... | 32                  | 27.8           | 84.3             | Valencia..... | 32                  | 53.2           | 73.2             |
|                       | 40                  | 27.3           | 54.8             |               | 40                  | 55.0           | 78.8             |
|                       | 70                  | 47.4           | 78.4             |               | 70                  | 60.8           | 60.2             |
| Jumbo.....            | 32                  | 23.3           | 66.0             |               |                     |                |                  |
|                       | 40                  | 73.9           | 72.1             |               |                     |                |                  |
|                       | 70                  | 40.0           | 54.9             |               |                     |                |                  |

<sup>1</sup> The percentages of germination are based upon slightly varying numbers of seeds planted for each lot. The exact number of seeds was recorded at planting time and was approximately 300 seeds for each lot.

TABLE 2.—*Average germination in 1922 of five varieties of peanut seed grown in 1921 and stored at 32°, 40°, and in common storage at 70° F.<sup>1</sup>*

| Storage temperature (° F.) | Average germination |                  | Storage temperatures compared | Difference in germination |                  | Significance of difference <sup>2</sup> |                  |
|----------------------------|---------------------|------------------|-------------------------------|---------------------------|------------------|-----------------------------------------|------------------|
|                            | Stored shelled      | Stored unshelled |                               | Stored shelled            | Stored unshelled | Stored shelled                          | Stored unshelled |
|                            | Per cent            | Per cent         | ° F.                          | Per cent                  | Per cent         | Odds                                    | Odds             |
| 32.....                    | 43.4                | 77.0             | 32 and 40                     | 16.2                      | 3.7              | 10:1                                    | 3:1              |
| 40.....                    | 59.6                | 73.3             | 32 and 70                     | 4.4                       | 11.5             | 3:1                                     | 832:1            |
| 70.....                    | 47.8                | 65.5             | 40 and 70                     | 11.8                      | 7.8              | 6:1                                     | 4:1              |

<sup>1</sup> The percentages of germination are based upon slightly varying numbers of seeds planted for each lot. The exact number of seeds was recorded at planting time and was approximately 300 seeds for each lot.

<sup>2</sup> In this and subsequent tables the odds indicate whether the differences in germination were due to the storage conditions, and odds of 30 to 1 or higher are considered significant. Odds of significance of difference are calculated by Student's method. See the following citations:

ANONYMOUS. ON THE ERROR OF COUNTING WITH A HAEMOCYTOMETER. By Student. *Biometrika* 5:351-360, illus. 1907.

— THE PROBABLE ERROR OF A MEAN. By Student. *Biometrika* 6:1-25, illus. 1908.

— NEW TABLES FOR TESTING THE SIGNIFICANCE OF OBSERVATIONS. By Student. *Metron*. 5:105-120. 1925.

The percentage of germination of shelled seed of African and Jumbo stored at 40° F. was significantly higher than that stored at 32°, but in all other instances storage temperature was without evident consistent effect upon germination. The reason for the exceptions noted is not evident.

The shelled seed gave definitely lower germination than that stored unshelled. Apparently this is in conflict with results published earlier <sup>1</sup> in which it was shown that seed shelled in December or January gave practically as good germination as that shelled immediately before planting. In the earlier work the seed was kept in a storeroom on the third floor of a steam-heated office building in which the relative humidity was low. In the present studies the seed was stored on the

<sup>1</sup> BEATTIE, J. H., HUNN, C. J., MILLER, F. E., CURRIN, R. E., and KYZER, E. D. EFFECT OF PLANTING DISTANCES AND TIME OF SHELLING SEED ON PEANUT YIELDS. U. S. Dept. Agr. Bul. 1478, 12 p. 1927.

ground floor of the cold-storage plant where the humidity was undoubtedly higher. These differences in storage conditions may account in part for this apparent discrepancy.

## EXPERIMENTAL WORK IN 1922-23

Stock of African, Improved Spanish, Jumbo, Spanish, Valencia, Virginia Bunch, and Virginia Runner varieties was planted at Florence May 15, 1922, and the resultant crop was harvested September 29, for a continuation of the cold-storage work during 1923. The peanuts were picked from the vines on November 22, 1922, and shipped to Arlington Experiment Farm, where they were prepared for storage as in the previous season's work by shelling one-half of each lot by hand. All lots, shelled and unshelled, were placed in storage at 32°, 40°, and 70° F. on November 25. On May 8, 1923, the seed was removed from storage, shipped to Florence, and planted on May 17. The seed stored unshelled was shelled by hand before planting. The results obtained are summarized in Tables 3 and 4.

TABLE 3.—*Germination in 1923 of seven varieties of peanut seed grown in 1922 and stored at 32°, 40°, and in common storage at 70° F.*

| Variety               | Storage temperature | Germination    |                  | Variety              | Storage temperature | Germination    |                  |
|-----------------------|---------------------|----------------|------------------|----------------------|---------------------|----------------|------------------|
|                       |                     | Stored shelled | Stored unshelled |                      |                     | Stored shelled | Stored unshelled |
|                       | °F.                 | Per cent       | Per cent         |                      | °F.                 | Per cent       | Per cent         |
| African.....          | 32                  | 86.3           | 89.4             | Valencia.....        | 32                  | 83.8           | 93.0             |
|                       | 40                  | 80.8           | 91.0             |                      | 40                  | 85.5           | 97.2             |
|                       | 70                  | 84.4           | 93.0             |                      | 70                  | 88.0           | 95.5             |
| Improved Spanish..... | 32                  | 89.1           | 88.8             | Virginia Bunch.....  | 32                  | 66.6           | 89.1             |
|                       | 40                  | 82.5           | 89.4             |                      | 40                  | 71.1           | 80.8             |
|                       | 70                  | 88.8           | 91.1             |                      | 70                  | 70.8           | 88.5             |
| Jumbo.....            | 32                  | 73.0           | 90.0             | Virginia Runner..... | 32                  | 71.1           | 94.7             |
|                       | 40                  | 94.1           | 87.5             |                      | 40                  | 71.9           | 87.2             |
|                       | 70                  | 86.9           | 86.3             |                      | 70                  | 71.4           | 93.8             |
| Spanish.....          | 32                  | 88.3           | 93.0             |                      |                     |                |                  |
|                       | 40                  | 91.3           | 91.9             |                      |                     |                |                  |
|                       | 70                  | 86.6           | 88.0             |                      |                     |                |                  |

TABLE 4.—*Average germination in 1923 of seven varieties of peanut seed grown in 1922 and stored at 32°, 40°, and in common storage at 70° F.*

| Storage temperature (°F.) | Average germination |                  | Storage temperatures compared | Difference in germination |                  | Significance of difference <sup>1</sup> |                  |
|---------------------------|---------------------|------------------|-------------------------------|---------------------------|------------------|-----------------------------------------|------------------|
|                           | Stored shelled      | Stored unshelled |                               | Stored shelled            | Stored unshelled | Stored shelled                          | Stored unshelled |
|                           | Per cent            | Per cent         | °F.                           | Per cent                  | Per cent         | Odds                                    | Odds             |
| 32.....                   | 79.7                | 91.1             | 32 and 40                     | 2.7                       | 1.8              | 3:1                                     | 5:1              |
| 40.....                   | 82.4                | 89.3             | 32 and 70                     | 1.6                       | .2               | 2:1                                     | 1:1              |
| 70.....                   | 78.1                | 90.9             | 40 and 70                     | 4.3                       | 1.6              | 3:1                                     | 3:1              |

<sup>1</sup> See footnote 2, Table 2.

The results for 1923 agree in general with the data for 1922. Unshelled seed gave a higher germination than the shelled seed, but there was no marked difference in the germination of the seed stored at different temperatures.

## EXPERIMENTAL WORK IN 1923-24

The work for 1923-24 included the same varieties and followed the same plan as that for previous seasons. Yield records were also obtained, thereby making possible additional comparisons.

Stock of the seven varieties grown at Florence from plantings made on May 17 and harvested September 27, 1923, was shipped to Arlington Experiment Farm and stored shelled and unshelled at 32°, 40°, and 70° F. on December 1, as before. This material was taken from storage about May 15, 1924, shipped to South Carolina, and planted on May 21. Seed stored unshelled was shelled by hand before planting. Two 90-foot rows, each containing 180 seeds spaced 6 inches apart, were planted from each lot of stored seeds. Germination counts were made three and five weeks after planting. There were no significant differences in germination or yield between lots of seed stored at different temperatures. Harvesting took place on September 27, and yield records were taken on December 12. (Tables 5 and 6.) No explanation is offered to account for the low germination of the seed stored unshelled as compared with that stored shelled.

TABLE 5.—*Germination and yields in 1924 of seven varieties of peanuts from seed grown in 1923 and stored at 32°, 40°, and in common storage at 70° F.*

| Variety               | Storage temperature | Germination    |                  | Yield per plot (0.01 acre) |        |                  |        |
|-----------------------|---------------------|----------------|------------------|----------------------------|--------|------------------|--------|
|                       |                     | Stored shelled | Stored unshelled | Stored shelled             |        | Stored unshelled |        |
|                       |                     |                |                  | Peanuts                    | Hay    | Peanuts          | Hay    |
|                       | °F.                 | Per cent       | Per cent         | Pounds                     | Pounds | Pounds           | Pounds |
| African.....          | 32                  | 79.4           | 57.5             | 8.25                       | 63.75  | 8.00             | 51.00  |
|                       | 40                  | 74.4           | 44.1             | 6.75                       | 68.25  | 5.50             | 39.00  |
|                       | 70                  | 80.0           | 57.7             | 7.50                       | 60.50  | 5.75             | 44.75  |
| Improved Spanish..... | 32                  | 84.4           | 68.5             | 14.25                      | 38.25  | 14.25            | 29.25  |
|                       | 40                  | 83.5           | 62.2             | 15.25                      | 37.25  | 16.25            | 31.25  |
|                       | 70                  | 86.6           | 62.2             | 15.75                      | 39.75  | 16.75            | 35.75  |
| Jumbo.....            | 32                  | 75.8           | 60.7             | 10.00                      | 100.00 | 9.00             | 69.00  |
|                       | 40                  | 87.4           | 51.1             | 7.00                       | 46.50  | 6.25             | 41.25  |
|                       | 70                  | 90.0           | 56.9             | 10.00                      | 63.50  | 7.50             | 67.50  |
| Spanish.....          | 32                  | 84.4           | 78.3             | 13.25                      | 33.25  | 9.50             | 22.00  |
|                       | 40                  | 84.1           | 77.7             | 10.25                      | 27.25  | 11.00            | 23.00  |
|                       | 70                  | 87.5           | 78.0             | 15.00                      | 33.50  | 10.50            | 32.50  |
| Valencia.....         | 32                  | 80.5           | 74.7             | 6.00                       | 27.50  | 6.25             | 30.25  |
|                       | 40                  | 84.7           | 73.8             | 6.50                       | 35.00  | 6.00             | 27.50  |
|                       | 70                  | 77.5           | 80.8             | 4.50                       | 21.50  | 5.75             | 20.75  |
| Virginia Bunch.....   | 32                  | 84.4           | 78.3             | 6.75                       | 46.25  | 13.25            | 83.75  |
|                       | 40                  | 84.1           | 77.7             | 14.00                      | 85.00  | 8.00             | 72.50  |
|                       | 70                  | 87.5           | 78.0             | 7.75                       | 59.75  | 13.50            | 76.50  |
| Virginia Runner.....  | 32                  | 81.6           | 79.7             | 8.25                       | 58.25  | 12.50            | 71.50  |
|                       | 40                  | 88.0           | 72.5             | 9.50                       | 51.00  | 8.00             | 56.50  |
|                       | 70                  | 87.7           | 66.1             | 12.00                      | 64.00  | 10.50            | 57.50  |

TABLE 6.—*Average germination in 1924 of seven varieties of peanut seed grown in 1923 and stored at 32°, 40°, and in common storage at 70° F.*

| Storage temperature (°F.) | Average germination |                  | Storage temperatures compared | Difference in germination |                  | Significance of difference <sup>1</sup> |                  |
|---------------------------|---------------------|------------------|-------------------------------|---------------------------|------------------|-----------------------------------------|------------------|
|                           | Stored shelled      | Stored unshelled |                               | Stored shelled            | Stored unshelled | Stored shelled                          | Stored unshelled |
|                           | Per cent            | Per cent         | °F.                           | Per cent                  | Per cent         | Odds                                    | Odds             |
| 32.....                   | 81.5                | 71.1             | 32 and 40                     | 2.2                       | 5.5              | 5:1                                     | 2:1              |
| 40.....                   | 83.7                | 65.6             | 32 and 70                     | 3.7                       | 2.6              | 16:1                                    | 5:1              |
| 70.....                   | 85.2                | 68.5             | 40 and 70                     | 1.5                       | 2.9              | 3:1                                     | 6:1              |

<sup>1</sup> See footnote 2, Table 2.

## EXPERIMENTAL WORK IN 1924-25

The work in 1924-25 followed the same lines as that in previous years. Material of the seven varieties grown at Florence during 1924 was harvested October 11 to November 4 and was picked and shipped to Arlington Experiment Farm December 2 and 3. Each variety was divided into two lots of 30 pounds each. One lot of each variety was shelled by hand on January 14, 1925, and both shelled and unshelled lots were placed in cold storage on January 15 in muslin bags, as before. The seed was removed from storage on May 1, shipped to Florence, and planted on May 4.

Two 90-foot rows were planted from each lot of seed, thus permitting 360 seeds 6 inches apart in the two rows. In 1925, contrary to previous years, the seed stored unshelled was planted unshelled, but the shells were broken apart when necessary so that only one seed was planted in each place. Germination counts were made three and five weeks after planting, but only final germination and yields are considered in the results. (Tables 7 and 8.)

TABLE 7.—*Germination and yields in 1925 of seven varieties of peanuts from seed grown in 1924 and stored at 32°, 40°, and in common storage at 70° F.*

| Variety               | Storage temperature | Germination    |                  | Yield per plot (0.01 acre) |        |                  |        |
|-----------------------|---------------------|----------------|------------------|----------------------------|--------|------------------|--------|
|                       |                     | Stored shelled | Stored unshelled | Stored shelled             |        | Stored unshelled |        |
|                       |                     |                |                  | Peanuts                    | Hay    | Peanuts          | Hay    |
|                       | °F.                 | Per cent       | Per cent         | Pounds                     | Pounds | Pounds           | Pounds |
| African.....          | 32                  | 58.9           | 69.7             | 8.25                       | 103.50 | 3.50             | 44.00  |
|                       | 40                  | 59.7           | 71.9             | 3.25                       | 64.75  | 5.50             | 73.50  |
|                       | 70                  | 66.1           | 60.0             | 6.75                       | 70.75  | 4.25             | 71.75  |
| Improved Spanish..... | 32                  | 71.7           | 81.9             | 9.25                       | 56.75  | 9.00             | 53.00  |
|                       | 40                  | 67.8           | 83.3             | 9.25                       | 47.25  | 9.75             | 51.25  |
|                       | 70                  | 68.3           | 76.1             | 10.00                      | 18.00  | 9.00             | 38.25  |
| Jumbo.....            | 32                  | 46.1           | 64.2             | 7.25                       | 67.25  | 8.25             | 33.25  |
|                       | 40                  | 43.6           | 61.4             | 5.00                       | 45.00  | 17.50            | 40.00  |
|                       | 70                  | 47.5           | 70.0             | 6.00                       | 44.50  | 7.00             | 70.00  |
| Spanish.....          | 32                  | 80.6           | 83.3             |                            |        |                  |        |
|                       | 40                  | 79.7           | 83.6             |                            |        |                  |        |
|                       | 70                  | 81.1           | 84.4             |                            |        |                  |        |
| Valencia.....         | 32                  | 89.2           | 89.7             | 4.25                       | 27.75  | 3.25             | 41.75  |
|                       | 40                  | 88.1           | 87.2             | 5.50                       | 42.00  | 5.00             | 38.50  |
|                       | 70                  | 78.9           | 73.6             | 3.75                       | 37.75  | 4.50             | 44.50  |
| Virginia Bunch.....   | 32                  | 20.3           | 72.8             | 6.50                       | 78.50  | 4.00             | 34.50  |
|                       | 40                  | 15.3           | 68.9             | 4.00                       | 44.00  | 7.75             | 68.75  |
|                       | 70                  | 23.6           | 78.9             | 4.50                       | 35.50  | 10.00            | 59.00  |
| Virginia Runner.....  | 32                  | 54.2           | 76.9             | 5.00                       | 52.50  | 9.25             | 58.75  |
|                       | 40                  | 35.6           | 71.9             | 6.00                       | 43.50  | 5.25             | 59.25  |
|                       | 70                  | 37.8           | 76.1             | 4.75                       | 47.75  | 5.75             | 79.25  |

TABLE 8.—*Average germination in 1925 of seven varieties of peanuts from seed grown in 1924 and stored at 32°, 40°, and in common storage at 70° F.*

| Storage temperature (°F.) | Average germination |                  | Storage temperatures compared | Difference in germination |                  | Significance of difference <sup>1</sup> |                  |
|---------------------------|---------------------|------------------|-------------------------------|---------------------------|------------------|-----------------------------------------|------------------|
|                           | Stored shelled      | Stored unshelled |                               | Stored shelled            | Stored unshelled | Stored shelled                          | Stored unshelled |
|                           | Per cent            | Per cent         | °F.                           | Per cent                  | Per cent         | Odds                                    | Odds             |
| 32.....                   | 60.1                | 76.9             | 32 and 40                     | 4.4                       | 1.4              | 16:1                                    | 8:1              |
| 40.....                   | 55.7                | 75.5             | 32 and 70                     | 2.5                       | 2.7              | 3:1                                     | 3:1              |
| 70.....                   | 57.6                | 74.2             | 40 and 70                     | 1.9                       | 1.3              | 4:1                                     | 2:1              |

<sup>1</sup> See footnote 2, Table 2.

These data are very similar to those obtained in other years and indicate that cold storage of peanut seed is not injurious to its vitality.

## EXPERIMENTAL WORK IN 1925-26

The experimental work was repeated during 1925-26. Peanut seed grown at Florence in 1925 was placed in storage at Arlington Experiment Farm in December. On May 10, 1926, this material was shipped to Florence, but planting did not take place until May 21. The plantings were duplications of those of 1924 and 1925. The results are summarized in Tables 9 and 10. In one respect the results of 1926 are not comparable with previous years because the unshelled seed was planted one pod in a place and some of these contained more than one kernel. However, comparisons of seed stored at various temperatures can be made. Unusually cool, wet weather at planting time, and subsequently, resulted in a low percentage of germination.

TABLE 9.—*Germination and yields in 1926 of seven varieties of peanuts from seed grown in 1925 and stored at 32°, 40°, and in common storage at 70° F.*

| Variety               | Storage temperature | Germination    |                  | Yield per plot (0.01 acre) |        |                  |        |
|-----------------------|---------------------|----------------|------------------|----------------------------|--------|------------------|--------|
|                       |                     | Stored shelled | Stored unshelled | Stored shelled             |        | Stored unshelled |        |
|                       |                     |                |                  | Peanuts                    | Hay    | Peanuts          | Hay    |
|                       | ° F.                | Per cent       | Per cent         | Pounds                     | Pounds | Pounds           | Pounds |
| African.....          | 32                  | 31.7           | 48.6             | 15                         | 60     | 18               | 72     |
|                       | 40                  | 18.1           | 42.8             | 11                         | 50     | 16               | 79     |
|                       | 70                  | 18.3           | 41.9             | 11                         | 38     | 22               | 78     |
| Improved Spanish..... | 32                  | 31.9           | 48.6             | 23                         | 39     | 33               | 39     |
|                       | 40                  | 27.8           | 49.4             | 21                         | 39     | 22               | 45     |
|                       | 70                  | 26.9           | 48.9             | 19                         | 36     | 25               | 51     |
| Jumbo.....            | 32                  | 12.2           | 22.2             | 11                         | 39     | 11               | 42     |
|                       | 40                  | 14.7           | 21.4             | 11                         | 40     | 17               | 55     |
|                       | 70                  | 15.0           | 34.2             | 13                         | 38     | 20               | 60     |
| Spanish.....          | 32                  | 46.1           | 57.2             | 18                         | 37     | 22               | 38     |
|                       | 40                  | 29.4           | 50.6             | 15                         | 41     | 21               | 44     |
|                       | 70                  | 51.9           | 53.1             | 20                         | 47     | 20               | 47     |
| Valencia.....         | 32                  | 26.9           | 40               | 15                         | 31     | 17               | 38     |
|                       | 40                  | 21.9           | 38.1             | 11                         | 29     | 13               | 28     |
|                       | 70                  | 30.7           | 44.7             | 11                         | 30     | 13               | 35     |
| Virginia Bunch.....   | 32                  | 13.1           | 34.7             | 11                         | 28     | 24               | 21     |
|                       | 40                  | 19.4           | 39.4             | 15                         | 40     | 25*              | 49     |
|                       | 70                  | 16.4           | 43.1             | 11                         | 43     | 28               | 80     |
| Virginia Runner.....  | 32                  | 19.2           | 43.3             | 13                         | 37     | 21               | 64     |
|                       | 40                  | 15.8           | 42.8             | 11                         | 34     | 24               | 61     |
|                       | 70                  | 21.4           | 41.1             | 15                         | 45     | 22               | 54     |

TABLE 10.—*Average germination in 1926 of seven varieties of peanut seed grown in 1925 and stored at 32°, 40°, and in common storage at 70° F.*

| Storage temperature<br>(° F.) | Average germination |                  | Storage temperatures compared | Difference in germination |                  | Significance of difference <sup>1</sup> |                  |
|-------------------------------|---------------------|------------------|-------------------------------|---------------------------|------------------|-----------------------------------------|------------------|
|                               | Stored shelled      | Stored unshelled |                               | Stored shelled            | Stored unshelled | Stored shelled                          | Stored unshelled |
|                               | Per cent            | Per cent         | ° F.                          | Per cent                  | Per cent         | Odds                                    | Odds             |
| 32.....                       | 25.9                | 42.1             | 32 and 40                     | 4.9                       | 1.5              | 11:1                                    | 14:1             |
| 40.....                       | 21                  | 40.6             | 32 and 70                     | .1                        | 1.7              | 1:1                                     | 2:1              |
| 70.....                       | 25.8                | 43.8             | 40 and 70                     | 4.8                       | 3.2              | 9:1                                     | 13:1             |

<sup>1</sup> See footnote 2, Table 2.

## SUMMARY OF STORAGE EXPERIMENTS

The results of the experiments for the years 1923, 1924, 1925, and 1926 are summarized in Tables 11 and 12. Germination data are for all four years, but yields are for three years only, except in the case of the Spanish variety where the yields are for two years. The data for 1922 are not included in the table as the size of the plantings made that year differed from those of subsequent years. The average percentage of germination given in Table 11 was determined by taking the average of the yearly percentage of germination, since all plantings considered were of the same size.

The data show that there is no consistent difference in the germination of the seed or in the yield of peanuts obtained from seed stored in cold storage at 32° and 40°, and in common storage at 70° F. Significant differences in germination between lots stored at different temperatures occurred in only 3 of 42 comparisons. (Table 11.) Even though these 3 are statistically significant, they are without doubt only chance differences and of no importance. From a consideration of these results it would seem that the cold storage of peanut seed is a safe practice since it causes no depression of germination or yield.

Although the earlier work heretofore referred to has shown it to be possible to store shelled seed in such a way as to retain its viability, the present work indicates that severe losses may result from shelling before placing the seed in storage. Losses from shelling before storing are often slight, but they may be appreciable. The effects of shelling are summarized in Table 12. It is doubtless a safer practice to store the seed in the unshelled state.

TABLE 11.—Average germination in 1923, 1924, 1925, and 1926, and yield in 1924, 1925, and 1926 of seven varieties of peanuts from seed stored at 32°, 40°, and in common storage at 70° F.

| Variety                    | Storage temperature |                   | Germination |       | Yield per plot (0.01 acre) |       |                   |           | Storage temperatures compared | Difference in germination <sup>1</sup> |          | Significance of difference |  |
|----------------------------|---------------------|-------------------|-------------|-------|----------------------------|-------|-------------------|-----------|-------------------------------|----------------------------------------|----------|----------------------------|--|
|                            |                     |                   |             |       | Stored shelled             |       | Stored un-shelled |           |                               |                                        |          |                            |  |
|                            | Stored shelled      | Stored un-shelled | Peanuts     | Hay   | Peanuts                    | Hay   |                   |           |                               |                                        |          |                            |  |
|                            |                     |                   |             |       |                            |       |                   |           |                               |                                        |          |                            |  |
| ° F.                       | P. ct.              | P. ct.            | Lbs.        | Lbs.  | Lbs.                       | Lbs.  | ° F.              | P. ct.    | P. ct.                        | Odds                                   | Odds     |                            |  |
| African -----              | 32                  | 64.1              | 66.3        | 10.50 | 75.75                      | 9.83  | 55.67             | 32 and 40 | +5.9                          | +3.8                                   | 13:1     | 3:1                        |  |
|                            | 40                  | 58.2              | 62.5        | 7.00  | 61.00                      | 9.00  | 63.83             | 32 and 70 | +1.9                          | +3.1                                   | 1:1      | 3:1                        |  |
|                            | 70                  | 62.2              | 63.2        | 8.41  | 56.42                      | 10.66 | 64.83             | 40 and 70 | -4.0                          | -1.7                                   | 30:1     | 1:1                        |  |
| Improved Spanish -----     | 32                  | 69.3              | 72.0        | 15.50 | 44.67                      | 18.75 | 40.42             | 32 and 40 | +3.9                          | +9                                     | 58:1     | 2:1                        |  |
|                            | 40                  | 65.4              | 71.1        | 15.17 | 41.17                      | 16.00 | 42.50             | 32 and 70 | +1.6                          | +4                                     | 5:1      | 4:1                        |  |
|                            | 70                  | 67.7              | 69.6        | 14.92 | 31.25                      | 16.92 | 41.67             | 40 and 70 | -2.3                          | -5                                     | 7:1      | 3:1                        |  |
| Jumbo -----                | 32                  | 51.8              | 59.3        | 9.42  | 68.75                      | 9.42  | 48.08             | 32 and 40 | -8.1                          | +3.9                                   | 8:1      | 12:1                       |  |
|                            | 40                  | 59.9              | 55.4        | 7.66  | 43.83                      | 13.58 | 45.42             | 32 and 70 | -6                            | -2.5                                   | 1:1      | 2:1                        |  |
|                            | 70                  | 52.4              | 61.8        | 9.67  | 48.67                      | 11.50 | 65.83             | 40 and 70 | +7.5                          | -6.4                                   | 3:1      | 17:1                       |  |
| Spanish <sup>2</sup> ----- | 32                  | 74.8              | 78.0        | 15.63 | 35.13                      | 15.75 | 30.00             | 32 and 40 | +3.7                          | +2.1                                   | 3:1      | 5:1                        |  |
|                            | 40                  | 71.1              | 75.9        | 12.63 | 34.13                      | 16.00 | 33.50             | 32 and 70 | -2.0                          | +2.1                                   | 5:1      | 6:1                        |  |
|                            | 70                  | 76.8              | 75.9        | 17.50 | 40.25                      | 15.25 | 39.75             | 40 and 70 | -5.7                          | 0.0                                    | 3:1      | 1:1                        |  |
| Valencia -----             | 32                  | 70.1              | 74.4        | 8.42  | 28.75                      | 8.83  | 36.67             | 32 and 40 | 0.0                           | +3                                     | 1:1      | 1:1                        |  |
|                            | 40                  | 70.1              | 74.1        | 7.67  | 35.33                      | 8.00  | 31.33             | 32 and 70 | +1.3                          | +7                                     | 1:1      | 1:1                        |  |
|                            | 70                  | 68.8              | 73.7        | 6.42  | 29.75                      | 7.75  | 33.42             | 40 and 70 | +1.3                          | +4                                     | 1:1      | 1:1                        |  |
| Virginia Bunch -----       | 32                  | 46.1              | 68.7        | 8.08  | 50.92                      | 13.75 | 46.42             | 32 and 40 | -1.4                          | +2.0                                   | 2:1      | 3:1                        |  |
|                            | 40                  | 47.5              | 66.7        | 11.00 | 56.33                      | 13.58 | 63.42             | 32 and 70 | -3.5                          | -3.4                                   | 10,000:1 | 7:1                        |  |
|                            | 70                  | 49.6              | 72.1        | 7.75  | 46.08                      | 17.17 | 71.83             | 40 and 70 | -2.1                          | -5.4                                   | 3:1      | 22:1                       |  |
| Virginia Runner -----      | 32                  | 56.5              | 73.7        | 8.75  | 49.25                      | 14.25 | 64.75             | 32 and 40 | +3.7                          | +5.1                                   | 3:1      | 37:1                       |  |
|                            | 40                  | 52.8              | 68.6        | 8.83  | 42.83                      | 12.42 | 58.92             | 32 and 70 | +1.9                          | +4.4                                   | 2:1      | 7:1                        |  |
|                            | 70                  | 54.6              | 69.3        | 10.58 | 52.25                      | 12.75 | 63.58             | 40 and 70 | -1.8                          | -7                                     | 5:1      | 1:1                        |  |
| All seven varieties -----  | 32                  | 61.8              | 70.3        |       |                            |       |                   | 32 and 40 | +1.1                          | +2.6                                   | 2:1      | 1:1                        |  |
|                            | 40                  | 60.7              | 67.7        |       |                            |       |                   | 32 and 70 | +1                            | +1.0                                   | 1:1      | 1:1                        |  |
|                            | 70                  | 61.7              | 69.3        |       |                            |       |                   | 40 and 70 | -1.0                          | -1.6                                   | 1:1      | 1:1                        |  |

<sup>1</sup> The + sign indicates superiority of the lower storage temperature with reference to subsequent germination. The - sign indicates the opposite.

<sup>2</sup> Yield data for Spanish for two years only.

TABLE 12.—*Summary data on germination and yield of seven varieties of peanuts from seed stored shelled and unshelled, at 32°, 40°, and in common storage at 70° F.*

| Storage conditions                      | 32° F.          | 40° F.          | 70° F.          |
|-----------------------------------------|-----------------|-----------------|-----------------|
| Average germination for four years:     | <i>Per cent</i> | <i>Per cent</i> | <i>Per cent</i> |
| Stored shelled.....                     | 61.8            | 60.7            | 61.7            |
| Stored unshelled.....                   | 70.3            | 67.7            | 69.3            |
| Difference.....                         | 8.5             | 7.0             | 7.6             |
| Significance of differences.....        | 1 700:1         | 1 20:1          | 1 58:1          |
| Average yield per plot for three years: | <i>Pounds</i>   | <i>Pounds</i>   | <i>Pounds</i>   |
| Stored shelled.....                     | 10.6            | 9.84            | 10.41           |
| Stored unshelled.....                   | 12.8            | 12.49           | 13.04           |
| Difference.....                         | 2.2             | 2.65            | 2.63            |
| Significance of differences.....        | 1 26:1          | 1 62:1          | 1 29:1          |

<sup>1</sup> Odds.

## EFFECT OF AGE

There has been some doubt regarding the effect of age on the germination of the seed and the crop grown therefrom. The work reported in the following pages was planned and executed for the purpose of obtaining additional information on the subject.

Two varieties, the Improved Spanish and the Valencia, were used in this work. Several bushels of each were grown at Florence in 1921. This seed was cured, picked by machine in the usual manner, and shipped to Washington, D. C., where it was stored in muslin bags in large galvanized-iron cans on the third floor of an office building. Similar lots from the 1922, 1923, 1924, 1925, and 1926 crops were stored in the same manner. The storage conditions were those normally existing in an office building, with winter temperatures of about 70° to 72° F., and summer temperatures often somewhat higher. No special precautions were taken to provide ventilation of the cans which were covered with rather loose-fitting hinged lids.

In the spring of 1922 a portion of the seed of each variety was removed and shelled immediately before planting. Two 90-foot rows of each variety were planted at Florence. The Valencia variety gave a germination of 52.5 per cent, and the Improved Spanish variety a germination of 84.5 per cent. This test was made to determine the percentage of germination of each variety at the age that peanut seed is ordinarily used. The low germination of the Valencia seed was thought to be due to injury from wet weather in 1921 before harvesting the seed crop. The Valencia has a very weak pod which splits easily in wet soil, thereby exposing the seeds to moisture and causing sprouting. No additional plantings were made until 1924.

The methods followed in conducting the germination and yield tests were as follows: A portion of seed of Valencia and Improved Spanish of all the ages available was removed from storage each year and shelled by hand in the spring just before planting time. Exactly 360 seeds of each variety were counted out, care being taken to reject all obviously imperfect specimens. The seed was planted in 90-foot rows, two to each variety, with the seeds spaced singly 6 inches apart in the rows. Two germination counts were made, one about two weeks and the other about four weeks after planting. The final count was used in making the comparisons. The results for the years during which these tests were conducted are summarized in Tables 13 and 14.

TABLE 13.—*Summarized data showing average percentage of germination of seed and yield of peanuts from seed of the Valencia and the Improved Spanish varieties grown at Florence, S. C., 1921-1926, and planted 1924-1927*

| Variety of seed and year produced | 1922 germination | 1924            |                | 1925            |                | 1926            |                | 1927            |                | Age of seed in 1927 | Relative germination, 1927 <sup>1</sup> |
|-----------------------------------|------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|---------------------|-----------------------------------------|
|                                   |                  | Germination     | Yield per plot | Germination     | Yield per plot | Germination     | Yield per plot | Germination     | Yield per plot |                     |                                         |
| Valencia:                         | <i>Per cent</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Years</i>        | <i>Per cent</i>                         |
| 1921.....                         | 52.5             | 55.8            | 6.00           | 48.8            | 4.50           | 34.0            | 11.0           | 47.2            | 4.0            | 6                   | 89.9                                    |
| 1922.....                         | -----            | 79.4            | 7.00           | 80.8            | 6.00           | 77.8            | 11.0           | 92.2            | 5.0            | 5                   | 116.1                                   |
| 1923.....                         | -----            | 75.8            | 5.75           | 79.7            | 7.00           | 86.4            | 11.0           | 94.4            | 6.0            | 4                   | 124.5                                   |
| 1924.....                         | -----            | -----           | -----          | 87.2            | 4.00           | 79.2            | 11.0           | 93.0            | 6.0            | 3                   | 106.65                                  |
| 1925.....                         | -----            | -----           | -----          | -----           | -----          | 74.7            | -----          | 88.9            | 5.0            | 2                   | 92.23                                   |
| 1926.....                         | -----            | -----           | -----          | -----           | -----          | -----           | -----          | 86.9            | 6.0            | 1                   | 100.00                                  |
| Improved Spanish:                 |                  |                 |                |                 |                |                 |                |                 |                |                     |                                         |
| 1921.....                         | 84.5             | 85.8            | 13.25          | 71.1            | 10.50          | 49.2            | 25.0           | 56.4            | 4.0            | 6                   | 66.8                                    |
| 1922.....                         | -----            | 87.2            | 14.50          | 84.1            | 6.75           | 71.4            | 21.0           | 65.6            | 7.0            | 5                   | 75.23                                   |
| 1923.....                         | -----            | 87.7            | 13.50          | 86.1            | 10.75          | 78.3            | 23.0           | 90.8            | 6.0            | 4                   | 103.53                                  |
| 1924.....                         | -----            | -----           | -----          | 85.8            | 11.75          | 79.7            | 18.0           | 89.2            | 10.0           | 3                   | 103.96                                  |
| 1925.....                         | -----            | -----           | -----          | -----           | -----          | 79.4            | 22.0           | 78.0            | 7.0            | 2                   | 98.24                                   |
| 1926.....                         | -----            | -----           | -----          | -----           | -----          | -----           | -----          | 90.8            | 11.0           | 1                   | 100.00                                  |

<sup>1</sup> The relative percentage of germination in 1927, with the percentage of germination considered as 100 the first year the seed was tested.

TABLE 14.—*Summarized data showing relative percentage of germination of seed and yield of peanuts from seed of the Valencia and the Improved Spanish varieties grown at Florence, S. C., 1921-1926, and planted 1924-1927*

| Variety of seed and year produced | 1924            |                | 1925            |                | 1926            |                | 1927            |                | Age of seed in 1927 |
|-----------------------------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|---------------------|
|                                   | Germination     | Yield per plot | Germination     | Yield per plot | Germination     | Yield per plot | Germination     | Yield per plot |                     |
| Valencia:                         | <i>Per cent</i> | <i>Pounds</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Per cent</i> | <i>Pounds</i>  | <i>Years</i>        |
| 1921.....                         | 100.3           | 100            | 92.9            | 75.0           | 64.8            | 183.3          | 89.9            | 66.7           | 6                   |
| 1922.....                         | 100             | 100            | 101.8           | 85.7           | 98              | 157.1          | 116.1           | 71.4           | 5                   |
| 1923.....                         | 100             | 100            | 105.1           | 121.8          | 114             | 191.4          | 124.5           | 104.4          | 4                   |
| 1924.....                         | -----           | -----          | 100             | 100.0          | 90.8            | 275.0          | 106.6           | 150.0          | 3                   |
| 1925.....                         | -----           | -----          | -----           | -----          | 100             | -----          | 92.2            | -----          | 2                   |
| 1926.....                         | -----           | -----          | -----           | -----          | -----           | -----          | 100             | -----          | 1                   |
| Improved Spanish:                 |                 |                |                 |                |                 |                |                 |                |                     |
| 1921.....                         | 101.5           | 100            | 84.1            | 79.2           | 58.2            | 188.6          | 66.8            | 30.2           | 6                   |
| 1922.....                         | 100             | 100            | 96.4            | 46.5           | 81.9            | 144.8          | 75.2            | 48.3           | 5                   |
| 1923.....                         | 100             | 100            | 98.2            | 79.6           | 89.2            | 170.5          | 103.5           | 44.4           | 4                   |
| 1924.....                         | -----           | -----          | 100             | 100.0          | 92.9            | 153.2          | 104             | 85.1           | 3                   |
| 1925.....                         | -----           | -----          | -----           | -----          | 100             | 100.0          | 98.2            | 31.8           | 2                   |
| 1926.....                         | -----           | -----          | -----           | -----          | -----           | -----          | 100             | -----          | 1                   |

On account of the apparently great competition between plants in the row and the probable large increase in yields of individual plants adjacent to missing hills, no attempt was made to correct the yields to a full-stand basis.

## DISCUSSION

The percentages of germination and the yields of peanuts are summarized in Table 13. Differences in yield between the crops of the various years are not especially significant, because weather and other conditions introduced marked variations from year to year which were so great as to obscure probable slight changes in germinating power and productivity of the seed.

It will be noted that rather wide differences in percentage of germination, and hence in the stand from different lots of seed, in a

single year were often accompanied by no appreciable differences in yield. These results may be accounted for in part by soil heterogeneity and in part by the larger yields of plants adjacent to missing hills. But the fact that yields obtained from poor stands sometimes equaled those from seed having a higher germination should not be taken as an indication that the use of poor seed is a profitable practice.

The percentage of germination of seed of different ages is plotted in Figures 1 and 2. The trends are shown by straight lines <sup>2</sup> calculated by use of the usual formula:

$$y = a + b (R)$$

in which

$$b = \frac{n (\Sigma Ry) - (\Sigma R) (\Sigma y)}{n (\Sigma R^2) - (\Sigma R)^2}$$

$$a = \frac{\Sigma y - b (\Sigma R)}{n}$$

$R$  = horizontal axis

$y$  = vertical axis

$n$  = number of items

$\Sigma$  = summation

The germination of Valencia stock grown in 1921 and tested in 1922 was 52.5 per cent; in 1927 the same stock showed a germination of 47.2 per cent, the relative loss in germination for the period being only 10.1 per cent, which was less than the differences that occurred from year to year during the test. The stock of the Improved Spanish variety, grown in 1921 and tested in 1922, had a germination of 84.5 per cent; in 1927 the germination was 56.4 per cent, an actual decrease of 28.1 per cent, and a relative loss of 33.2 per cent or one-third of its original germination. The germination of this variety did not change materially for about three years, but thereafter it dropped somewhat rapidly.

In Table 14 the percentages of germination and yields obtained in the years 1924 to 1927 are expressed in relative terms, with the initial test of each lot of seed stock considered as 100. By thus reducing the figures for each lot of seed stock to a common basis of comparison, the relative change in germination and productivity with increasing age is more clearly shown. Thus, by "checking out" original differences in germination of various lots of seed, it is obvious that in the Valencia seed there was practically no loss in germination for five years, and but little loss in the sixth year. The Improved Spanish, however, showed a possibly significant loss in the fourth year and a consistent and appreciable loss in germination after being stored more than four years. For the reasons stated above, the figures for yield shown in Table 14 should be given little weight, although it does appear that the yields from the oldest lots of seed of both varieties in 1927 were distinctly lower than any of the lots 1 to 5 years old.

Most of the results indicate that yield was influenced predominantly by the seasonal conditions existing in the years in which the tests were

<sup>2</sup> For further information on methods used in plotting straight-line curves or trends, the reader is referred to the following publication: STATISTICAL METHODS, APPLIED TO ECONOMICS AND BUSINESS. MILLS, F. C. Ed. 2, 604 p., illus. New York, 1928.

made. Germination was apparently also affected but to a lesser degree. Unusually cool, wet weather at planting time, and subsequently, resulted in poor germination of all lots in 1926, and a dry summer in 1927 greatly reduced the yields that year. The germination curves for the seed of the Improved Spanish variety grown in 1921 and in 1922, and for that of the Valencia grown in 1921 show a rather definite downward trend, but such a condition is not evident in the other curves. The upward trend of the curves for germination of Valencia seed grown in 1922, 1923, and 1924 must not be misinterpreted to indicate that germination improves with age, but rather

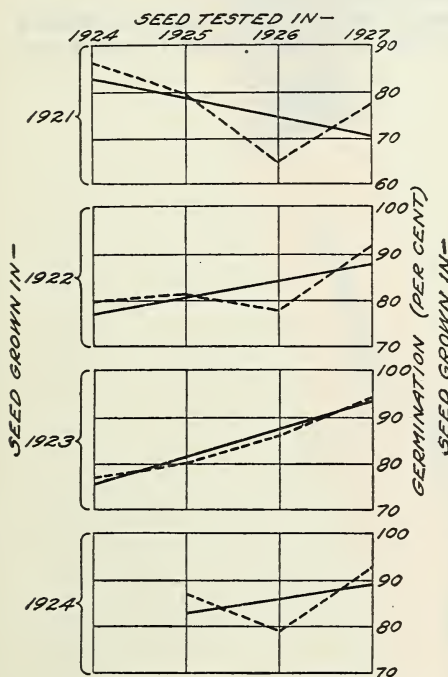


FIGURE 1.—Graphic presentation of percentage of germination of Valencia peanut seed of different ages. Trends shown by straight lines

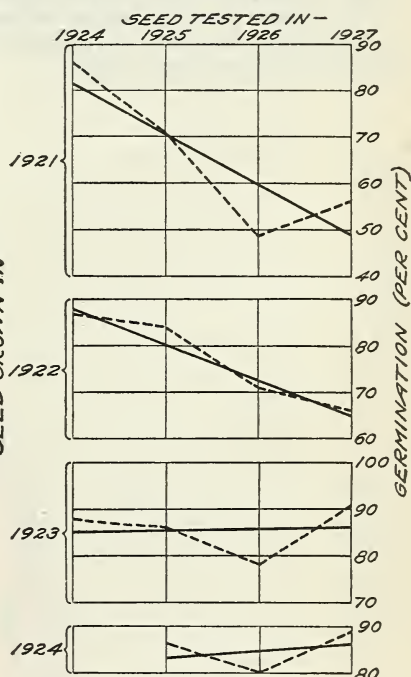


FIGURE 2.—Graphic presentation of percentage of germination of Improved Spanish peanut seed of different ages. Trends shown by straight lines

that no noticeable decrease in germination was evident. Variations in soil and climatic conditions during the germination period doubtless caused most of the subsequent fluctuations in percentage of germination of the seed produced in any one year. Furthermore, seed produced in one year may germinate better in subsequent years than seed actually not so old but which was produced under less favorable conditions.

Slight losses in stand from lowered germination have not been reflected in the yields obtained in these investigations. This is probably due partly to the fact that the loss of yield through missing hills is largely made up by the increased yields of hills adjacent to the missing ones.

## SUMMARY OF AGE EXPERIMENTS

With the Valencia variety of peanuts there was but small loss in germination with seed up to 5 years old. With the Improved Spanish variety, seed 3 years old germinated practically the same as did 1-year old seed, but when kept longer it suffered a distinct loss in germination.

The seed used in these experiments was stored unshelled in galvanized-iron cans in a dry place where temperatures averaged about 70° F. in winter and a few degrees higher in summer. Seed stored under other conditions might give different results.

It appears that by proper storage it should be practical to retain a satisfactory viability of peanut seed for about three to six years, depending upon the variety.



